



# FINAL WELL REPORT

## WELL 25/7-3

CN00012192  
25/7-3 D-01

### GEOLOGY AND GEOPHYSICS

Section B  
Page 23 of 29

## 10.0 FMT ANALYSIS

### 10.1 Formation Pressure Tests

FMT runs were performed in logging run 1D. The results are presented in table 15. A total of 20 pressure point were planned over the interval ranging from 2097.5-2270 m MD where 19 were successfully recorded.

*Table 15: FMT Analysis*

Test No.	Depth (MD)	Initial Hydrostatic (bar)		Formation Pressure (bar)		Final Hydrostatic (bar)		Temp Deg C	Remarks	
		Strain	HP	Strain	HP	Strain	HP			
1	2097,5	250,9	250,8	200,6	200,7	250,6	250,8	73,2	tight	
2	2102,5	251,1	252,4							
3	2103	251,0	251,4	200,6	201,1	251,1	251,4	73,9		
4	2103,7	251,0	251,5	200,5	201,1	251,1	251,5	74,4		
5	2104,8	251,1	251,6	200,5	201,2	251,2	251,7	74,3		
6	2110,5	251,7	252,3	200,9	201,6	251,8	252,3	74,4		
7	2111,5	251,7	252,4	201,0	201,7	251,8	252,4	74,6		
8	2112	252,4	252,5	201,7	201,8			77,9		oil sample
9	2112,5	251,9	252,5	201,4	201,8	252,3	252,5	74,8		
10	2113,5	252,3	252,7	201,4	201,9	252,4	252,6	75,0		
11	2114	252,6	252,7	201,7	201,9	252,7	252,7	75,5		
12	2116,5	252,9	253,0	201,9	202,1	253,1	253,0	75,3		
13	2118,1	253,1	253,2	202,1	202,3	253,2	253,2	75,7		
14	2127,5	254,2	254,3	203,1	203,3	254,3	254,3	76,0		
15	2132	254,7	254,8	203,6	203,7	255,0	254,8	76,2		
16	2136	255,3	255,3	204,0	204,1	255,4	255,3	76,5		
17	2148	256,6	256,7	205,2	205,3	256,8	256,7	77,0		
18	2176	260,1	260,1	208,1	208,2	260,1	260,0	77,2		
19	2246	268,3	268,3	215,0	215,0	268,5	268,2	77,8		
20	2270	271,1	271,4	217,6	217,4	271,5	271,1			

### 11.2 Formation Fluid Samples

A PVT oil sample was taken at the depth of 2112 m MD. The fluid was described as medium to dark brown with moderate viscosity and dull to intermediate white to pale yellow direct fluorescence. The report "PVT analysis of FMT sample" of Schlumberger GeoQuest, report no. Cono10, gives detailed information on this test.



# Mud & Product Use 36" & 17 1/2" sections

Operator: Conoco Norway Inc

Well 25/7-3

Initial volume  (m3) Vol trans to 17 1/2" section (m3): 200

Date 1995		27-07	28-07	29-07	30-07		
FSR no.		1	2	3	4		
Depth at 24:00 hr	m	172	228	792	1186	Total	Total
Section		36"	36"	17 1/2"	17 1/2"	section	section
<b>Mud Usage:</b>						36"	17 1/2"
Built	m3	227	209	307	264	436	571
Received	m3	0	0	0	0	0	0
Surface loss	m3	0	0	0	0	0	0
Dumped	m3	0	0	0	0	0	0
Riserless	m3	20	216	225	546	236	771
Solids equipment	m3	0	0	0	0	0	0
Formation loss	m3	0	0	0	0	0	0
Behind casing	m3	0	0	0	0	0	0
Left in hole	m3	0	0	0	0	0	0
Back-loaded	m3	0	0	0	0	0	0
<b>Final volume</b>	<b>m3</b>	<b>207</b>	<b>200</b>	<b>282</b>	<b>0</b>		
<b>Product Additions:</b>							
Barite	mt	0	46	95	17	46	112
Bentonite	mt	42	32	22	13	74	35
Soda Ash	kg	100	200	150	125	300	275
Lime	kg	0	0	60	0	0	60
CMC EHV	kg	0	250	0	0	250	0

# Mud and Product Usage, 12 1/4" section

Operator: Conoco Norway Inc

Well 25/7-3

Initial volume 138 Volume transferred to 8 1/2" section (m3): 222

Date 1995		31-07	01-08	02-08	03-08	04-08	
FSR no.		5	6	7	8	9	
Depth at 24:00 hr	m	1186	1186	1413	1965	1965	<b>Total</b>
Section		12 1/4"	12 1/4"	12 1/4"	12 1/4"	12 1/4"	<b>section</b>
<b>Mud Usage:</b>							<b>12 1/4"</b>
Built	m3	151	76	38	47	71	<b>383</b>
Received	m3	0	0	0	0	0	<b>0</b>
Surface loss	m3	0	0	0	0	14	<b>14</b>
Dumped	m3	0	0	0	0	15	<b>15</b>
Riserless	m3	0	0	0	0	0	<b>0</b>
Solids equipment	m3	0	0	48	68	12	<b>128</b>
Formation loss	m3	0	0	0	0	132	<b>132</b>
Behind casing	m3	0	0	0	0	10	<b>10</b>
Lost in hole	m3	0	0	0	0	0	<b>0</b>
Back-loaded	m3	0	0	0	0	0	<b>0</b>
<b>Final volume</b>	<b>m3</b>	<b>289</b>	<b>365</b>	<b>355</b>	<b>334</b>	<b>222</b>	

### Product Additions:

Barite	mt	0	65	38	20	24	<b>147</b>
Soda Ash	kg	0	0	0	100	0	<b>100</b>
Wyoming Bentonite	kg	0	0	0	0	475	<b>475</b>
Anco 208	ltr	7000	1000	4500	2750	2000	<b>17250</b>
KCl sxs	kg	0	0	0	0	8000	<b>8000</b>
KCl Brine	m3	128	0	24	0	30	<b>182</b>
Sodium Bicarb	kg	0	0	0	0	300	<b>300</b>
Citric Acid	kg	0	0	0	0	0	<b>0</b>
Anco Defoamer	kg	0	0	0	20	0	<b>20</b>
Rhodopol 23 P	kg	750	600	375	100	500	<b>2325</b>
Antisol FL 10	kg	850	750	0	750	750	<b>3100</b>
K D 40	ltr	0	0	0	460	0	<b>460</b>
Ancocide	ltr	0	25	50	0	0	<b>75</b>
Anco 2000 mud	m3	138	0	0	0	0	<b>138</b>



L-819

3



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**Karbon/oksygen isotopstudie av 3 prøver**

Oversender herved resultatene og kort rapport på oppdraget.

Med vennlig hilsen

*Tor Bjørnstad*

Tor Bjørnstad  
Avdelingssjef  
Reservoar- og Leteteknologi

*Kjersti Iden*  
Kjersti Iden  
Forsker

Vedlegg: 1 tabell  
3 diffraktogrammer  
Prosedyrebeskrivelse

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*Ekstra kopi til A.I. Jenssen.*

## **Carbon / oxygen isotope study of three carbonate cemented sandstones, Well 25/7-3**

*by Harald Johansen , Kjersti Iden and Ingar Johansen  
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### **XRD identification**

For isotopic analysis of carbonates, it is necessary to know which carbonate type to be analyzed (sample treatment). It was therefore agreed on use of XRD to establish the type of carbonate occurring in the actual samples.

### *Method*

Samples were crushed in an agate mortar. 0.3 - 0.4 g sample were further crushed in an agate micronizing mill for 2 minutes, using distilled water, to obtain the optimal grain size for analysis. The suspension was filtered on a 0.45µm Millipore filter, and dried at room temperature. The bulk sample was then mounted unoriented on holders adapted to the XRD equipment.

Samples were run on an INEL XRG 3000 diffractometer, equipped with a multichannel CPS 120 ° (curved position sensitive) detector, which records all 2θ positions from 1 to 120° simultaneously. The resolution is about 0.03° 2θ . Operating conditions were 35 kV, 35 mA, counting time: 900 seconds. Samples are horizontally rotated during acquisition.

### *Results*

**Calcite** is the only carbonate cement present. Contents are estimated to about 50% in the two upper samples, and to about 70 % in sample 2126.75m. The mineralogy is further dominated by quartz. Only small amounts of mica, kaolinite and feldspars are noted. The diffractograms are enclosed, and diagnostic peaks are pointed out.

### **Carbon / oxygen isotopes**

The analytical results are given in the enclosed Table.

Table.  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  analyses of the calcite cemented sandstones

Sample	IFEno	$\delta^{13}\text{C}_{\text{PDB}}$	$\delta^{18}\text{O}_{\text{PDB}}$
25/7-3 2116.0m	GEO960756	-11.1	-12.9
25/7-3 2116.65m	GEO960757	-13.3	-14.0
25/7-3 2126.75m	GEO960758	-27.3	-12.3
NSB-18	Standard	-5.1	-23.2



D I F F R A C T I N E L

25/7-3 2116.0m

I N E L

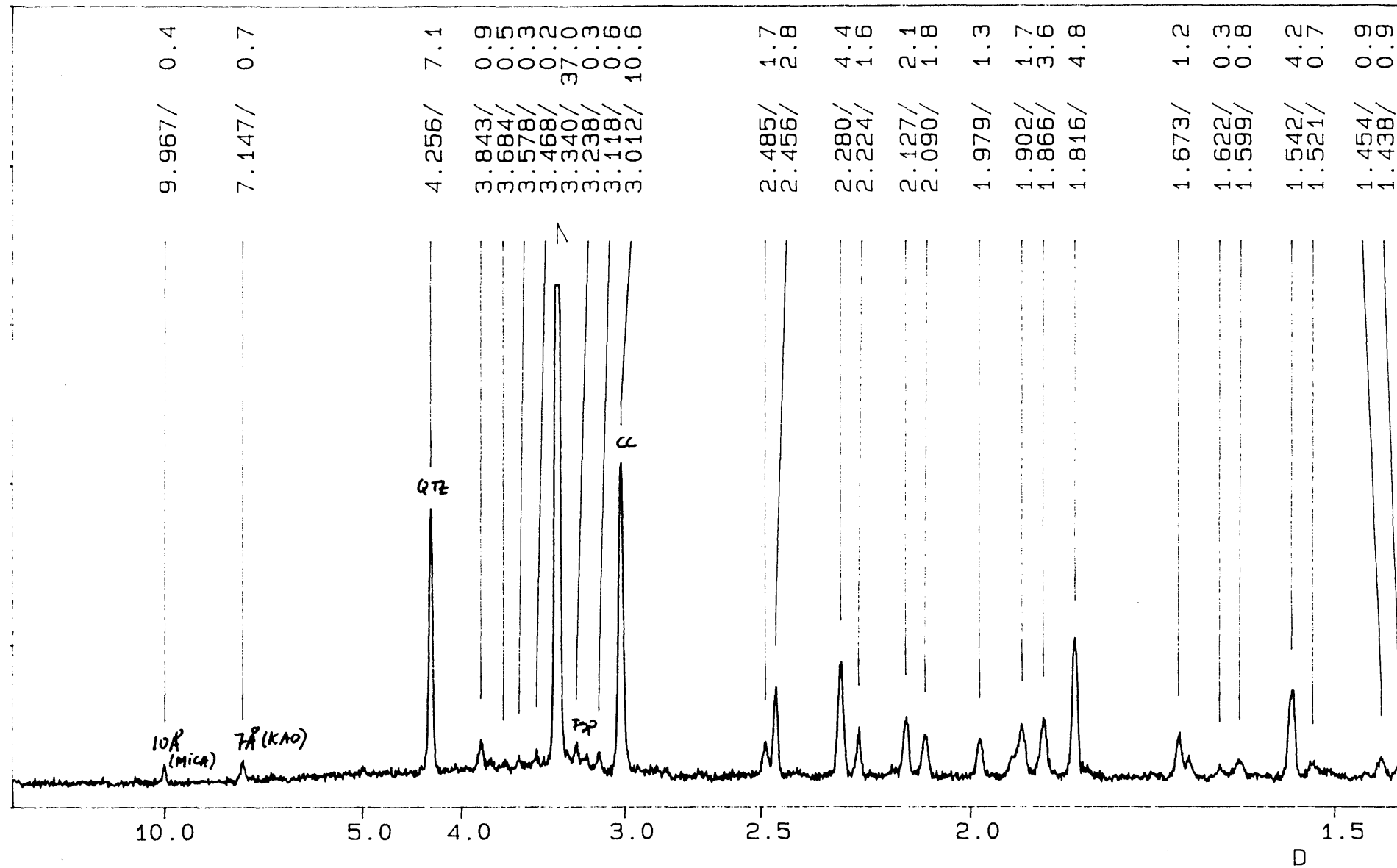
SAMPLE ESS01.DAT

ESS01.FXD

LIN Y-MAX=

5000.00 THRESHOLD:

0.00%



CALIBRATION: SIOCAL5.CAL

LAMBDA= 1.5405600 A, U= 35.00 KV, I= 35.00 MA, DATE=12/ 6/96 15: 3, T= 900.SEC

D I F F R A C T I N E L

25/7-3 2116.65m

I N E L

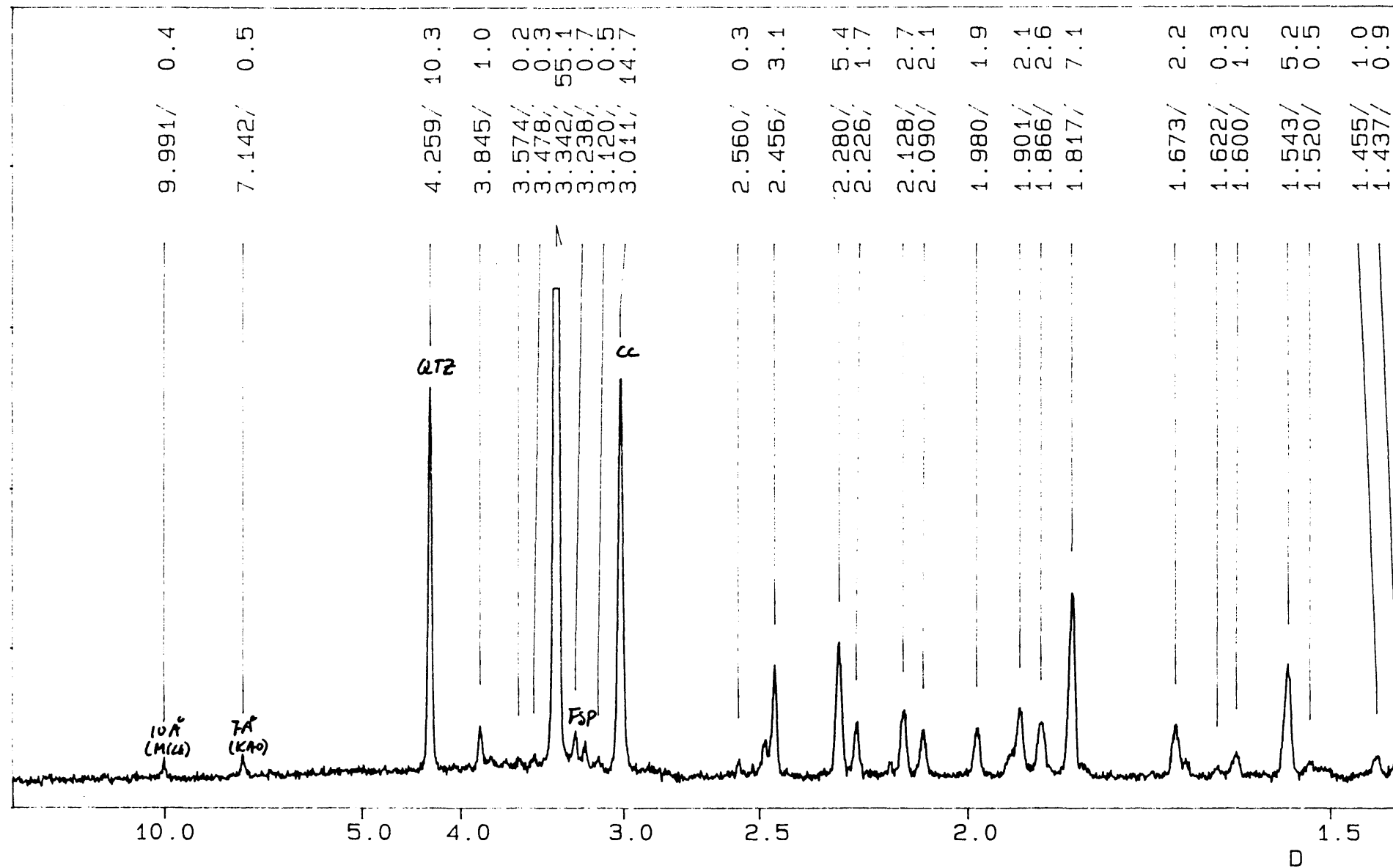
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ESS02.FXD

LIN Y-MAX=

5000.00 THRESHOLD:

0.00%



CALIBRATION: SIOCAL5.CAL

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D I F F R A C T I N E L

25/7-3 2126.75m

I N E L

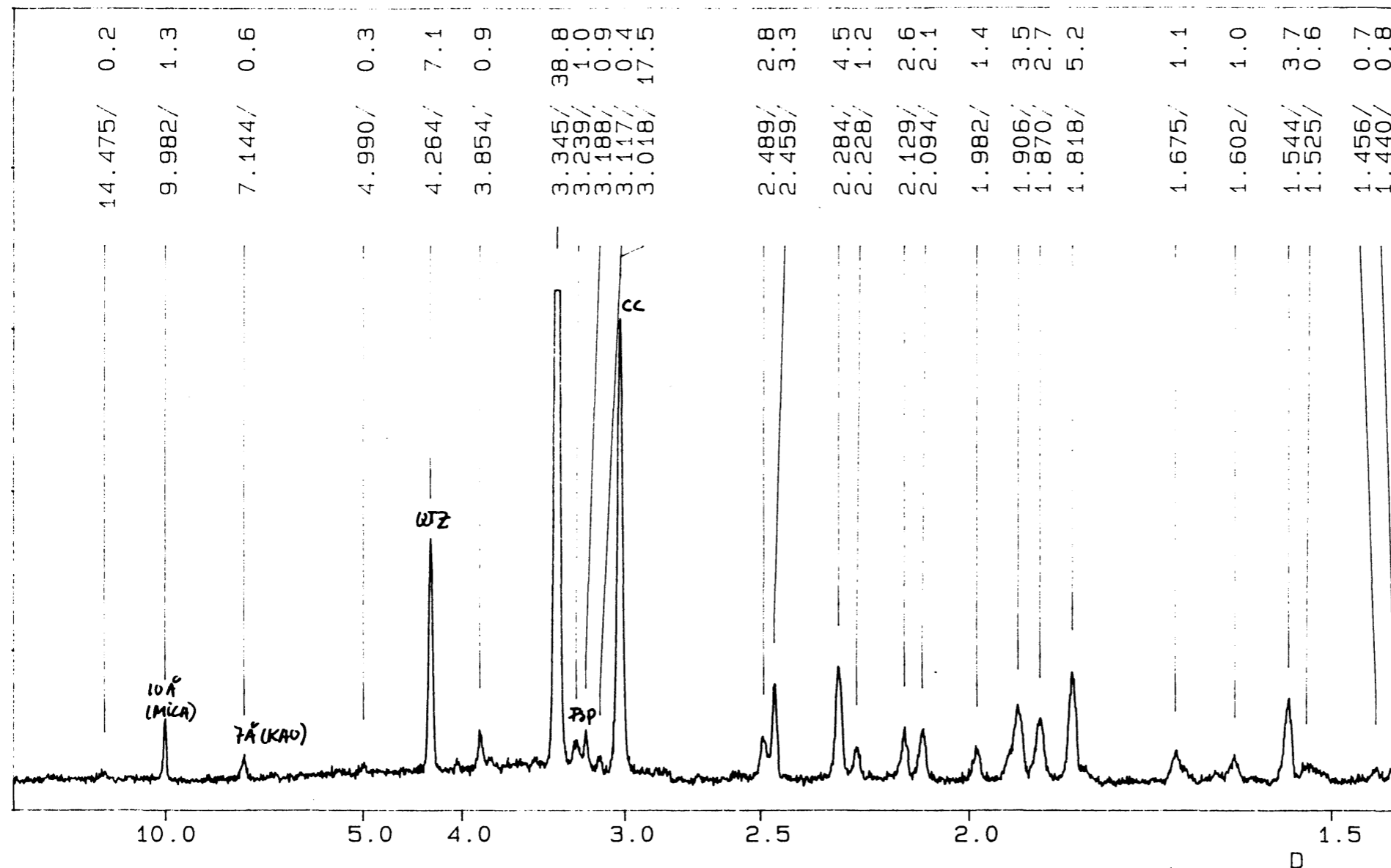
SAMPLE ESS03.DAT

ESS03.FXD

LIN Y-MAX=

5000.00 THRESHOLD:

0.00%



CALIBRATION: SIOCAL5.CAL

LAMBDA= 1.5405600 A, U= 35.00 KV, I= 35.00 MA, DATE=12/ 6/96 15: 34, T=

900.SEC

## Analytical procedure

$\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  isotope analysis :

20 mg grinded sample is dried in an oven for 4 hours and 400 °C, transferred to a glass container with 2ml 100%  $\text{H}_3\text{PO}_4$  and evacuated to  $<10^{-3}$  mbar. The reaction is controlled in a waterbath at 25 °C for 2 hours. The produced  $\text{CO}_2$  gas was then cleaned through a cooling trap at -80 °C before analysed on a Fisons VG Optima, Isotope Ratio Mass Spectrometer.

## Analytical precision and quality control

Based on repeated analysis of laboratory standards, the precisions of reported results are as followed :

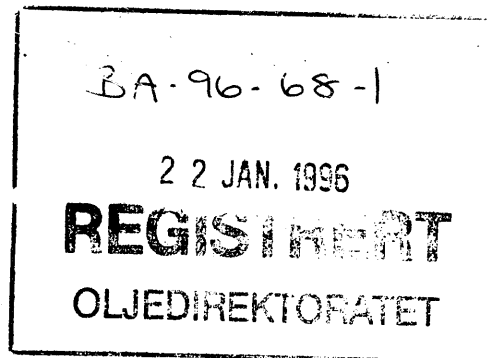
$\delta^{13}\text{C}$  analysis  $\pm 0.1\text{‰}$

$\delta^{18}\text{O}$  analysis  $\pm 0.2\text{‰}$

Element analysis  $\pm 5\%$

The stable isotope analysis is checked with analyses of NBS-18 standard, with the following results :

$\delta^{13}\text{C}_{\text{PDB}}$	$-5.12 \pm 0.08$	$(-5.029 \pm 0.05 \text{ recommended by IAEA})$
$\delta^{18}\text{O}_{\text{PDB}}$	$-22.93 \pm 0.12$	$(-23.035 \pm 0.17 \text{ recommended by IAEA})$



## Geochemical Report for

### Well NOCS 25/7-3

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Date :

28.11.95

## Chapter 1

# INTRODUCTION

### 1.1 General Comments

The well NOCS 25/7-3 is located south of the Heimdal field and north-west of the Balder and Hermod fields, just south east of the oil show in well 25/8-5S drilled by Esso in 1994. The well was drilled to a total depth of 2571 m into the Cretaceous (NPD Press Release). The well was classified as an oil discovery as hydrocarbons were detected in Palaeocene sandstones (740 Sm<sup>3</sup> oil/day and 29000 Sm<sup>3</sup> gas/day through a 25 mm choke)

This study is aimed at characterising the potential source and reservoir rocks and the hydrocarbons contained therein. In addition detailed analyses were performed over the cored hydrocarbon-bearing section to establish the oil-water contact.

The cuttings samples were washed and cleaned using water before all samples were lithologically described and picked, while the core chips and side-wall cores were analysed after cleansing of any superficial contamination. Both screening and follow-up analyses were performed in the depth range 1220 - 2530 m using 5 core chip, 14 side wall cores and 55 cuttings samples.

## 1.2 Analytical Program

<u>Analysis type</u>	<u>No of sample</u>	<u>Figures</u>	<u>Tables</u>
Lithology description	74	1	1
TOC	73	1	1,2
Rock-Eval pyrolysis	73	2-5	2
Thermal extraction GC (GHM, S <sub>1</sub> )	7	6a-c	
Pyrolysis GC (GHM, S <sub>2</sub> )	7	7a-b	3
Soxhlet Extraction of organic matter	5		
MPLC separation	6	4	
Whole oil GC	1	8	
Saturated hydrocarbon GC	6	9a-b	5
Aromatic hydrocarbon GC	6	10a-b	6
GC - MS of saturated and aromatic HC	6	13a-z	7-i
Isotope composition C <sub>15</sub> + fractions	6	11,12	8a-b

## Chapter 2

### SCREENING ANALYSES

A total of 76 samples, covering the depth interval 1220 - 2530 m, was supplied by Conoco. The cuttings samples were washed, and all samples lithologically described (Table 1), and 72 selected lithologies analysed by TOC/Rock-Eval (Table 2). Figure 1 is a lithological column with relevant stratigraphic information and TOC values. Figures 2, 3, 4 and 5 show the hydrogen index,  $S_1$ -Yields, production index and  $T_{max}$  plotted as a function of depth respectively. Based on thermal extraction-gas chromatography (see chapter 3) the samples are stained by additives from the drilling mud. This has probably affected the Rock Eval data (i.e. raised  $S_1$  and  $S_2$  values and lowered  $T_{max}$  values). Hence the classification of kerogen type will overestimate the quality and make assessment of maturity based on  $T_{max}$  difficult if not impossible.

#### 2.1 Lithology, TOC and Rock-Eval



## ***Experimental Procedures***

### **Headspace Gas Analysis**

The analysis is performed using a Perkin Elmer 8310 gas chromatograph with a 50 m Plot fused silica Al<sub>2</sub>O<sub>3</sub>/KCL column, loop injector and flame ionization detector. Nitrogen is used as carrier gas and the column is run from 70°C to 200°C, at a rate of 12°C/min. Final hold time is 5 min.

Two cm<sup>3</sup> of headspace gas are removed from each sample can for chromatographic analysis of the C<sub>1</sub> to C<sub>7</sub> range of hydrocarbons.

### **Occluded Gas Analysis**

The gas chromatograph used for this analysis is identical to that used for headspace gas analysis and is operated under the same conditions.

The canned samples are washed in thermostat-controlled water to remove drilling contaminants and sieved on a 2 mm mesh sieve to remove large, caved rock fragments. An aliquot (ca 25 mg) of sieved sample is crushed with 25 cm<sup>3</sup> water in an airtight ball mill. After crushing, 2 cm<sup>3</sup> of the released gas are removed from the ball mill for gas chromatographic analysis.

### **Total Organic Carbon (TOC) and Total Carbon Analysis**

This analysis is performed using a LECO CS244 Carbon Analyser.

Hand-picked lithologies from cuttings samples are crushed with a mortar and pestle and approximately 200 mg (50 mg for coals) are accurately weighed into LECO

crucibles. The samples are then treated three times with 10 % hydrochloric acid to remove oxidized (carbonate) carbon, and washed four times with distilled water. The samples are dried on a hotplate at 60 - 70°C before analysis of total organic carbon. Total carbon is also analysed on the same instrument using approximately 200 mg of untreated crushed whole rock. Oxidized (carbonate) carbon is calculated by weight difference.

Total organic carbon can also be analysed on the Rock-Eval II Pyrolyser during the normal run of the instrument.

### **Rock-Eval Pyrolysis**

This analysis is performed by using a Rock-Eval II Pyrolyser. Approximately 100 mg crushed whole rock is analysed. The sample is first heated at 300°C for three min in an atmosphere of helium to release the free hydrocarbons present (S1 peak) and then pyrolysed by increasing the temperature from 300°C to 600°C (temp. gradient 25°C/min) (S2 peak). Both the S1 and S2 yields are measured using a flame ionization detector (FID). In the temperature interval between 300°C and 390°C, the released gases are split and a proportion passed through a carbon dioxide trap, which is connected to a thermal conductivity detector (TCD). The value obtained from the TCD corresponds to the amount of oxygen contained in the kerogen of the sample and is reported as the S3 peak.

The Rock-Eval II Pyrolyser also analyses the TOC of each sample during the normal run of the instrument.

### **Thermal Extraction/Pyrolysis Gas Chromatography**

The instrument used for this analysis is a Varian 3400 Gas Chromatograph interfaced to a pyrolysis oven (the pyrolyser). Up to 15 mg of whole rock sample is loaded on the

pyrolyser and heated isothermally, at 300°C, for 4 min, during which time thermal extraction of the free hydrocarbons occurs (equivalent to the S1 peak of the Rock-Eval). The released gases pass to a 25 m OV1 column with a liquid nitrogen-cooled trap.

After 4 min the pyrolysis oven is temperature programmed up to 530°C, at a rate of 37°C/min, causing bound hydrocarbons to be released from the kerogen (equivalent to the S2 peak of the Rock-Eval). The released gases pass to a 25 m OV1 column with a liquid nitrogen-cooled trap.

The temperature program of the gas chromatograph oven, in which the columns are housed is -10°C to 290°C at a rate of 6°C/min.

Both the columns are linked to a FID.

### **Solvent Extraction of Organic Matter (EOM)**

The samples are extracted using a Tecator Soxtec HT-System. Carefully weighed samples are taken in a pre-extracted thimble. Some activated copper is added to the extraction cup and dichloromethane is used as an extraction solvent. The samples are boiled for 1 hour and then rinsed for 2 hours. If the samples contain more than 10 % TOC, then the whole procedure is repeated once. The resulting solution is filtered and the solvent removed by rotary evaporation (200 mb, 30°C). The amount of EOM is gravimetrically established.

### **Removal of Asphaltenes**

Asphaltenes are removed from the EOM by precipitation in n-pentane. N-pentane is added to the EOM and the solution is then stored in the dark and at ambient temperature for at least 8 hours. The solution is then filtered (Baker 10-spe system)

and the precipitated asphaltenes dissolved in dichloromethane are returned to the original flask. The solvent is removed by rotary evaporation (200 mb and 30°C).

### **latroscan**

Saturates, aromatics, polars and asphaltenes were qualitatively and quantitatively assessed using latroscan TLC-FID and employing Chromarod S-III rods. Approximately 3 - 4 drops of oil was accurately weighed and dissolved in about 3 ml of solvent, to get a strength of about 10 - 15 mg/ml. 2 ul of this solution was spotted on the rod (rods are pre-activated) using an auto-spotter with continuous blowing using nitrogen. The rods are first developed using n-hexane (35 mins) as the mobile phase followed by toluene (14 mins) and DCM-MeOH (4 mins), with 2 minutes air drying between every stage. The developed rods are then introduced in the pre-heated oven (60°C) for 90 seconds. They are analysed using latroscan and data collected and processed using Multichrom data system.

### **Chromatographic Separation of Deasphaltened EOM**

Chromatographic separation is performed using an MPLC system developed by the company. The EOM (minus asphaltenes) is injected into the MPLC and separated using hexane as an eluent. The saturated and aromatic hydrocarbon fractions are collected and the solvent removed using a rotary evaporator at 30°C. The fractions are then transferred to small pre-weighed vials and evaporated to dryness in a stream of nitrogen. The vials are re-weighed to obtain the weights of both the saturated and the aromatic fractions. The weight of the NSO fraction which is retained on the column, is obtained by weight difference.

### **Gas Chromatographic Analyses**

Saturated hydrocarbon fractions:

The instrument used for this analysis is a PERKIN ELMER 8320 Gas Chromatograph equipped with an FID detector and an OV1 column. The carrier gas is helium and the temperature program runs from 80°C to 300°C at a rate of 4°C/min. Final hold time is 20 mins. The saturated hydrocarbon fraction is diluted by 1:30 and a 1 microlitre aliquot of this is injected into the instrument.

Aromatic hydrocarbon fractions:

The instrument used is a Varian 3400 Gas Chromatograph with a 25 m SE 54 capillary column, split injector and a column splitter leading to FID and FPD detectors, which allows simultaneous analysis of co-eluting hydrocarbons and sulphur compounds. The carrier gas is helium and the temperature program runs from 40°C to 290°C at a rate of 4°C/min. Final hold time is 10 mins. The aromatic hydrocarbon fraction is diluted by 1:30 and a 1 microlitre aliquot of this is injected into the instrument.

#### **Whole Oil/Whole Extract**

Whole oil chromatograms are determined on a Perkin Elmer Sigma 2000 gas chromatograph fitted with a split injector, 25 m SE54 capillary column and effluent splitter connected to FID and FPD detectors allowing simultaneous determination of hydrocarbons and sulphur compounds. Approximately 0.1 microlitres of whole oil are injected and the temperature program on the chromatograph runs from -10°C to 300°C at 4°C/min.

#### **Combined Gas Chromatography - Mass Spectrometry (GC-MS)**

The GC-MS analyses are performed on a VG TS250 system interfaced to a Hewlett Packard 5890 gas chromatograph. The GC is fitted with a fused silica SE54 capillary column (40 m x 0.22 mm i.d.) directly into the ion source. Helium (12 psi) is used as

carrier gas and the injections are performed in splitless mode. The GC oven is programmed from 45°C to 150°C at 35°C/min, at which point the programme rate is 2°C/min up to 310°C where the column is held isothermally for 15 min. For the aromatic hydrocarbons, the GC oven is programmed from 50°C to 310°C at 5°C/min. and held isothermally at 310°C for 15 min. The mass spectrometer is operated in electron impact (EI) mode at 70 eV electron energy, a trap current of 500 uA and a source temperature of 220°C. The instrument resolution used is 1500 (10 % value).

The data system used is a VG PDP11/73 for acquiring data, and a Vax station 3100 for peak processing the data. The samples are analysed in multiple ion detection mode (MID) at a scan cycle time of approximately 1.1 sec.

Calculation of peak ratios is performed from peak heights in the appropriate mass fragmentograms.

### **Saturated Fractions**

#### **Terpanes**

The most commonly used fragment ions for detection of terpanes are M/Z 163 for detection of 25,28,30 trisnormoretane or 25,28,30 trisnorhopane, M/Z 177 for detection of demethylated hopanes or moretanes, M/Z 191 for detection of tricyclic, tetracyclic- and pentacyclic terpanes and M/Z 205 for methylated hopanes or moretanes. The molecular ions M/Z 370 and 384 are also recorded for identification of C<sub>27</sub> and C<sub>28</sub> triterpanes respectively.

#### **Steranes**

The most commonly used fragment ions for detection of steranes are M/Z 149 to distinguish between 5 $\alpha$  and 5 $\beta$  steranes, M/Z 189 and 259 for detection of rearranged

steranes, M/Z 217 for detection of rearranged and normal steranes and M/Z 218 for detection of  $14\beta(H)$   $17\beta(H)$  steranes.

The M/Z 231 fragment ion is used to detect possible aromatic contamination of the saturated fraction. It is also used for detection of methyl steranes.

## Aromatic Fractions

### Alkyl-substituted Benzenes

The M/Z 106 fragment ion is often used to detect the alkyl-substituted benzenes. It is especially useful for the detection of di-substituted benzenes. M/Z 134 can also be used for the detection of C<sub>4</sub>-alkylbenzenes, but benzothiophene will also give a signal with this fragment ion.

### Naphthalenes

Methyl naphthalenes are normally detected by the M/Z 142 fragment ion, while C<sub>2</sub>-naphthalenes are detected by M/Z 156 and C<sub>3</sub>-naphthalenes by M/Z 170.

### Benzothiophenes and Dibenzothiophenes

Benzothiophene can be detected, as mentioned above, by M/Z 134. The M/Z 198 and M/Z 212 fragment ions are used for methyl-substituted dibenzothiophenes and dimethyl-substituted dibenzothiophenes respectively.

### Phenanthrenes

Phenanthrene is detected using the M/Z 178 fragment ion. Anthracene will, if present, also give a signal in the M/Z 178 fragment ion. Methyl-substituted phenanthrenes give signals in the M/Z 192 fragment ion, while the M/Z 206 fragment ion shows the dimethyl-substituted phenanthrenes and the M/Z 220 fragment ion shows the C<sub>3</sub> substituted phenanthrenes.



## Aromatic Steranes

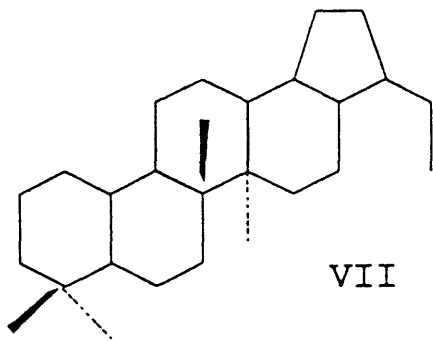
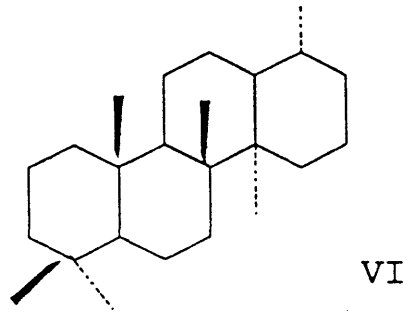
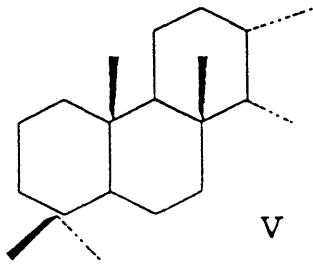
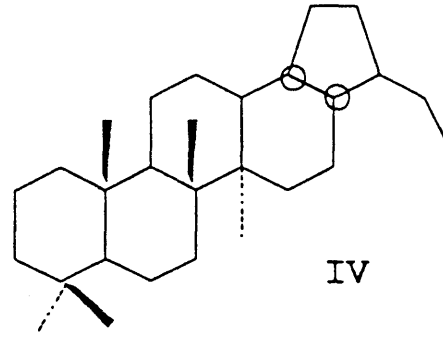
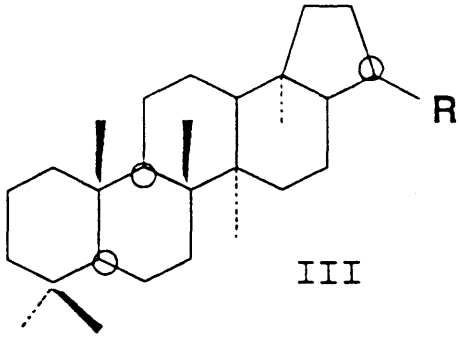
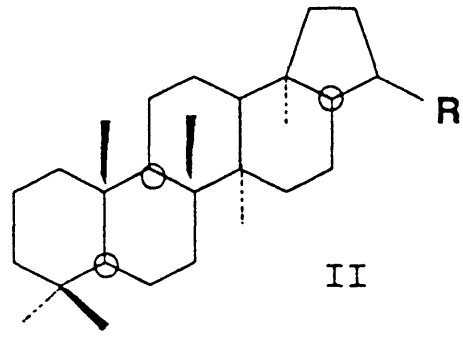
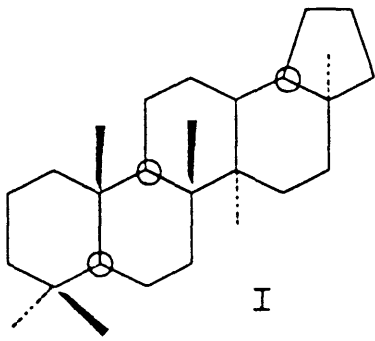
Monoaromatic steranes are detected using the M/Z 253 fragment ion, while the triaromatic steranes are detected using the M/Z 231 fragment ion.

**Mass Fragmentograms representing Terpanes**  
**(M/Z 163, 177, 191, 205, 370, 384, 398, 412 and 426)**

Peak Identification: ( $\alpha$  and  $\beta$  refer to hydrogen atoms at C-17 and C-21 respectively unless indicated otherwise)

A.	18 $\alpha$ trisnorneohopane (T <sub>s</sub> )	C <sub>27</sub> H <sub>44</sub>	( I )
B.	17 $\alpha$ trisnorhopane (T <sub>m</sub> )	C <sub>27</sub> H <sub>46</sub>	( II, R=H )
Z.	Bisnorhopane	C <sub>28</sub> H <sub>48</sub>	( IV )
C.	$\alpha\beta$ norhopane	C <sub>29</sub> H <sub>50</sub>	( II, R=C <sub>2</sub> H <sub>5</sub> )
D.	$\beta\alpha$ norhopane	C <sub>29</sub> H <sub>50</sub>	( III, R=C <sub>2</sub> H <sub>5</sub> )
E.	$\alpha\beta$ hopane	C <sub>30</sub> H <sub>52</sub>	( II, R=i-C <sub>3</sub> H <sub>7</sub> )
F.	$\beta\alpha$ hopane	C <sub>30</sub> H <sub>52</sub>	( III, R=i-C <sub>3</sub> H <sub>7</sub> )
G.	22S $\alpha\beta$ homohopane	C <sub>31</sub> H <sub>54</sub>	( II, R=i-C <sub>4</sub> H <sub>9</sub> )
H.	22R $\alpha\beta$ homohopane	C <sub>31</sub> H <sub>54</sub>	( II, R=i-C <sub>4</sub> H <sub>9</sub> )
I.	$\beta\alpha$ homohopane	C <sub>31</sub> H <sub>54</sub>	( III, R=i-C <sub>4</sub> H <sub>9</sub> )
J.	22S $\alpha\beta$ bishomohopane	C <sub>32</sub> H <sub>56</sub>	( II, R=i-C <sub>5</sub> H <sub>11</sub> )
	22R $\alpha\beta$ bishomohopane	C <sub>32</sub> H <sub>56</sub>	( II, R=i-C <sub>5</sub> H <sub>11</sub> )
K.	22S $\alpha\beta$ trishomohopane	C <sub>33</sub> H <sub>58</sub>	( II, R=i-C <sub>6</sub> H <sub>13</sub> )
	22R $\alpha\beta$ trishomohopane	C <sub>33</sub> H <sub>58</sub>	( II, R=i-C <sub>6</sub> H <sub>13</sub> )
L.	22S $\alpha\beta$ tetrakishomohopane	C <sub>34</sub> H <sub>60</sub>	( II, R=i-C <sub>7</sub> H <sub>15</sub> )
	22R $\alpha\beta$ tetrakishomohopane	C <sub>34</sub> H <sub>60</sub>	( II, R=i-C <sub>7</sub> H <sub>15</sub> )
M.	22S $\alpha\beta$ pentakishomohopane	C <sub>35</sub> H <sub>62</sub>	( II, E=i-C <sub>8</sub> H <sub>17</sub> )
	22R $\alpha\beta$ pentakishomohopane	C <sub>35</sub> H <sub>62</sub>	( II, R=i-C <sub>8</sub> H <sub>17</sub> )
P.	Tricyclic terpane	C <sub>23</sub> H <sub>42</sub>	( V, R=i-C <sub>4</sub> H <sub>9</sub> )
Q.	Tricyclic terpane	C <sub>24</sub> H <sub>44</sub>	( V, R=i-C <sub>5</sub> H <sub>11</sub> )
R.	Tricyclic terpane (17R, 17S)	C <sub>25</sub> H <sub>46</sub>	( V, R=i-C <sub>6</sub> H <sub>13</sub> )
S.	Tetracyclic terpane	C <sub>24</sub> H <sub>42</sub>	( VI )
T.	Tricyclic terpane (17R, 17S)	C <sub>26</sub> H <sub>48</sub>	( V, R=i-C <sub>7</sub> H <sub>15</sub> )
N.	Tricyclic terpane	C <sub>21</sub> H <sub>38</sub>	( V, R=C <sub>2</sub> H <sub>5</sub> )
O.	Tricyclic terpane	C <sub>22</sub> H <sub>40</sub>	( V, R=C <sub>3</sub> H <sub>7</sub> )
Y.	25,28,30-trisnorhopane/moretane	C <sub>27</sub> H <sub>46</sub>	( VII )
X.	$\alpha\beta$ diahopane	C <sub>30</sub> H <sub>52</sub>	( VIII )

STRUCTURES REPRESENTING TERPANES



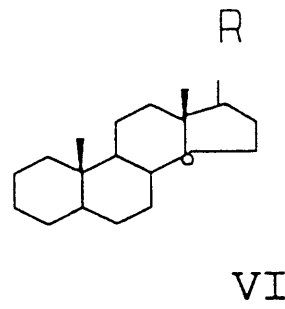
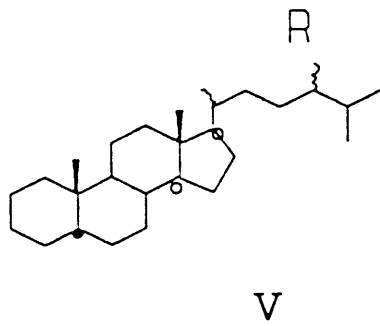
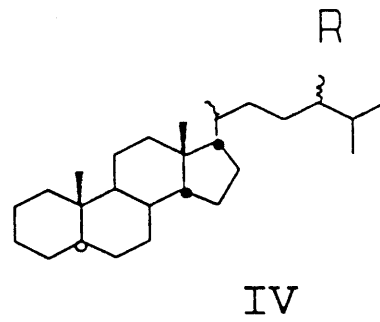
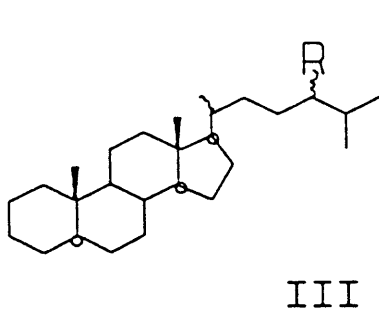
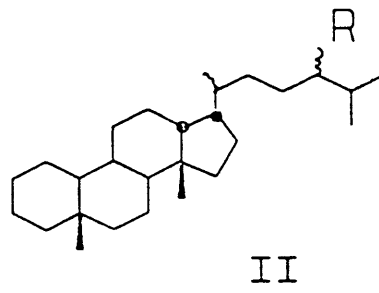
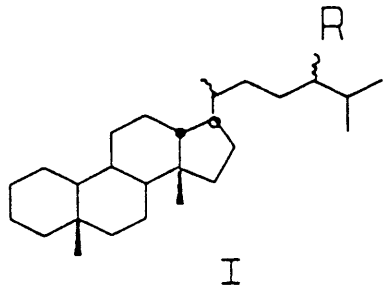
**Mass Fragmentograms representing Steranes**

(M/Z 149, 189, 217, 218, 259, 372, 386, 400 and 414)

Peak Identifications:  $\alpha$  and  $\beta$  refer to hydrogen atoms at C-5, C-14 and C-17 in regular steranes and at C-13 and C-17 in diasteranes).

a.	20S $\beta\alpha$ diacholestane	$C_{27}H_{48}$	( I, R=H)
b.	20R $\beta\alpha$ diacholestane	$C_{27}H_{48}$	( I, R=H)
c.	20S $\alpha\beta$ diacholestane	$C_{27}H_{48}$	( II, R=H)
d.	20R $\alpha\beta$ diacholestane	$C_{27}H_{48}$	( II, R=H)
e.	20S $\beta\alpha$ 24-methyl-diacholestane	$C_{28}H_{50}$	( I, R=CH <sub>3</sub> )
f.	20R $\beta\alpha$ 24-methyl-diacholestane	$C_{28}H_{50}$	( I, R=CH <sub>3</sub> )
g.	20S $\alpha\beta$ 24-methyl-diacholestane	$C_{28}H_{50}$	( II, R=CH <sub>3</sub> )
	+ 20S $\alpha\alpha\alpha$ cholestane	$C_{27}H_{48}$	(III, R=H)
h.	20S $\beta\alpha$ 24-ethyl-diacholestane	$C_{29}H_{52}$	( II, R=C <sub>2</sub> H <sub>5</sub> )
	+ 20R $\alpha\beta\beta$ cholestane	$C_{27}H_{48}$	( IV, R=H)
i.	20S $\alpha\beta\beta$ cholestane	$C_{27}H_{48}$	( IV, R=H)
	+ 20R $\alpha\beta$ 24-methyl-diacholestane	$C_{28}H_{50}$	( II, R=CH <sub>3</sub> )
j.	20R $\alpha\alpha\alpha$ cholestane	$C_{27}H_{48}$	(III, R=H)
k.	20R $\beta\alpha$ 24-ethyl-diacholestane	$C_{29}H_{52}$	( I, R=C <sub>2</sub> H <sub>5</sub> )
l.	20R $\alpha\beta$ 24-ethyl-diacholestane	$C_{29}H_{52}$	( II, R=C <sub>2</sub> H <sub>5</sub> )
m.	20S $\alpha\alpha\alpha$ 24-methyl-cholestane	$C_{28}H_{50}$	(III, R=CH <sub>3</sub> )
n.	20R $\alpha\beta\beta$ 24-methyl-cholestane	$C_{28}H_{50}$	( IV, R=CH <sub>3</sub> )
	+ 20R $\alpha\beta$ 24-ethyl-diacholestane	$C_{29}H_{52}$	( II, R=C <sub>2</sub> H <sub>5</sub> )
o.	20S $\alpha\beta\beta$ 24-methyl-cholestane	$C_{28}H_{50}$	( IV, R=CH <sub>3</sub> )
p.	20R $\alpha\alpha\alpha$ 24-methyl-cholestane	$C_{28}H_{50}$	(III, R=CH <sub>3</sub> )
q.	20S $\alpha\alpha\alpha$ 24-ethyl-cholestane	$C_{29}H_{52}$	(III, R=C <sub>2</sub> H <sub>5</sub> )
r.	20R $\alpha\beta\beta$ 24-ethyl-cholestane	$C_{29}H_{52}$	( IV, R=C <sub>2</sub> H <sub>5</sub> )
s.	20S $\alpha\beta\beta$ 24-ethyl-cholestane	$C_{29}H_{52}$	( IV, R=C <sub>2</sub> H <sub>5</sub> )
t.	20R $\alpha\alpha\alpha$ 24-ethyl-cholestane	$C_{29}H_{52}$	(III, R=C <sub>2</sub> H <sub>5</sub> )
u.	5 $\alpha$ sterane	$C_{21}H_{36}$	( VI, R=C <sub>2</sub> H <sub>5</sub> )
v.	5 $\alpha$ sterane	$C_{22}H_{38}$	( VI, R=C <sub>3</sub> H <sub>7</sub> )

STRUCTURES REPRESENTING STERANES

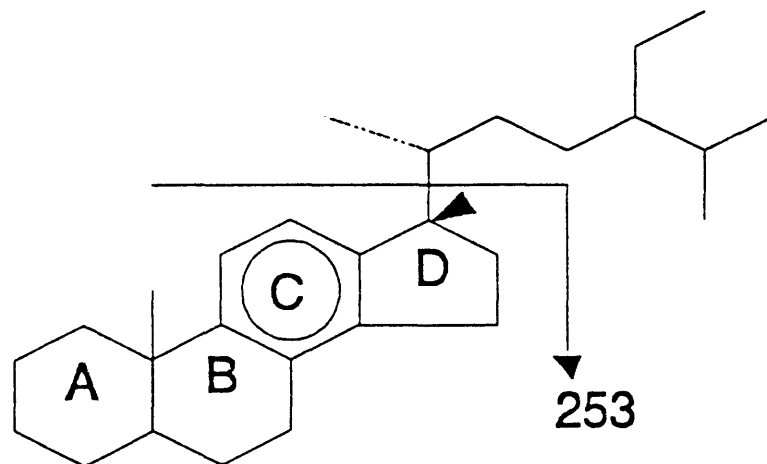


**Mass Fragmentograms representing Monoaromatic Steranes  
(M/Z 253)**

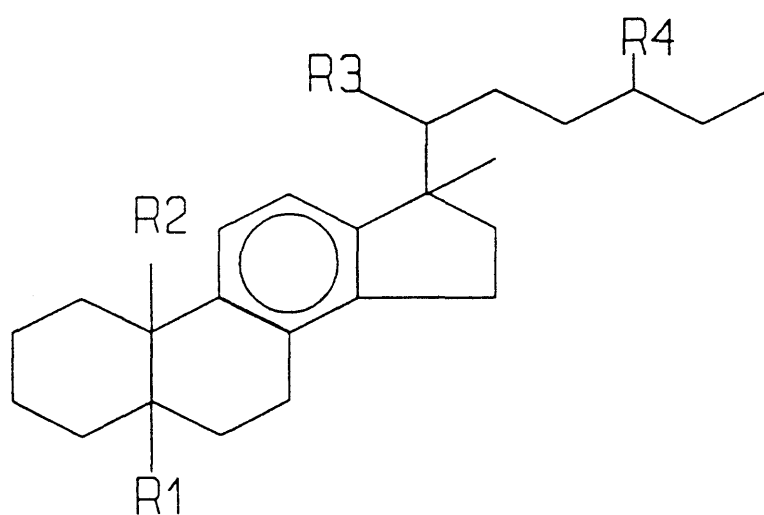
Description of C-ring monoaromatic steroid hydrocarbons

Peak	Substituents				Abbreviation of Compound
	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	
A1					C <sub>21</sub> M
B1					C <sub>22</sub> MA
C1	β(H)	CH <sub>3</sub>	S(CH <sub>3</sub> )	H	βSC <sub>27</sub> MA
	β(H)	CH <sub>3</sub>	R(CH <sub>3</sub> )	H	βRC <sub>27</sub> MA
D1	CH <sub>3</sub>	H	R(CH <sub>3</sub> )	H	RC <sub>27</sub> DMA
	α(H)	CH <sub>3</sub>	S(CH <sub>3</sub> )	H	αSC <sub>27</sub> MA
E1	β(H)	CH <sub>3</sub>	S(CH <sub>3</sub> )	CH <sub>3</sub>	βSC <sub>28</sub> MA
	CH <sub>3</sub>	H	S(CH <sub>3</sub> )	CH <sub>3</sub>	SC <sub>28</sub> DMA
F1	α(H)	CH <sub>3</sub>	R(CH <sub>3</sub> )	H	αRC <sub>27</sub> MA
	α(H)	CH <sub>3</sub>	S(CH <sub>3</sub> )	CH <sub>3</sub>	αSC <sub>28</sub> MA
	β(H)	CH <sub>3</sub>	R(CH <sub>3</sub> )	CH <sub>3</sub>	βRC <sub>28</sub> MA
G1	CH <sub>3</sub>	H	R(CH <sub>3</sub> )	CH <sub>3</sub>	RC <sub>28</sub> DMA
	β(H)	CH <sub>3</sub>	S(CH <sub>3</sub> )	C <sub>2</sub> H <sub>5</sub>	βSC <sub>29</sub> MA
	CH <sub>3</sub>	H	S(CH <sub>3</sub> )	C <sub>2</sub> H <sub>5</sub>	SC <sub>29</sub> DMA
	α(H)	CH <sub>3</sub>	R(CH <sub>3</sub> )	CH <sub>3</sub>	αRC <sub>28</sub> MA
H1	β(H)	CH <sub>3</sub>	R(CH <sub>3</sub> )	C <sub>2</sub> H <sub>5</sub>	βRC <sub>29</sub> MA
	CH <sub>3</sub>	H	R(CH <sub>3</sub> )	C <sub>2</sub> H <sub>5</sub>	RC <sub>29</sub> DMA
I1	α(H)	CH <sub>3</sub>	R(CH <sub>3</sub> )	C <sub>2</sub> H <sub>5</sub>	αRC <sub>29</sub> MA

STRUCTURE REPRESENTING MONOAROMATIC STERANES



I



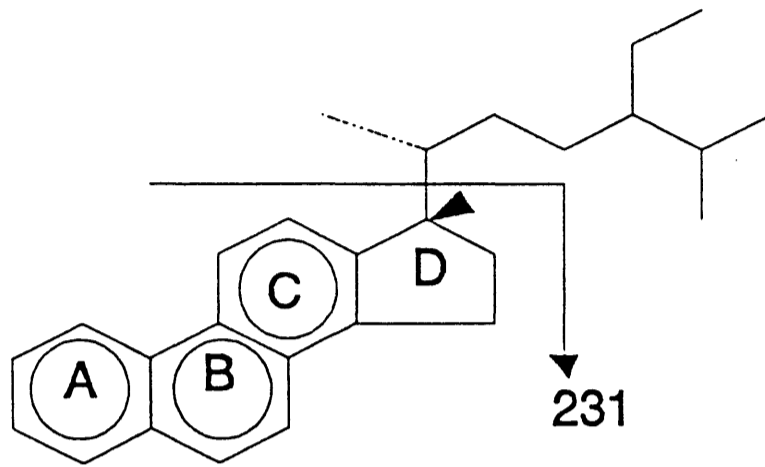
**Mass Fragmentograms representing Triaromatic Steranes  
(M/Z 231)**

Description of ABC-ring triaromatic steroid hydrocarbons

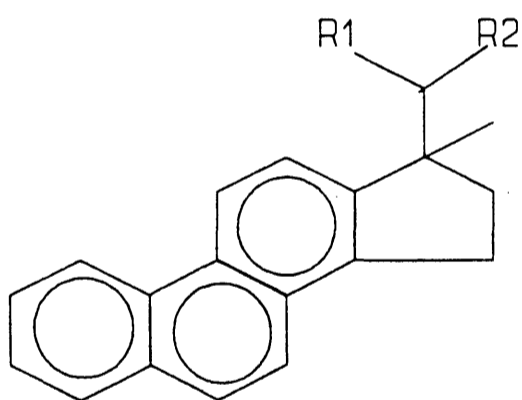
Peak	Substituents		Abbreviation of Compound
	R <sub>1</sub>	R <sub>2</sub>	
a1	CH <sub>3</sub>	H	C <sub>20</sub> TA
b1	CH <sub>3</sub>	CH <sub>3</sub>	C <sub>21</sub> TA
c1	S(CH <sub>3</sub> )	C <sub>6</sub> H <sub>1-3</sub>	SC <sub>26</sub> TA
d1	R(CH <sub>3</sub> )	C <sub>6</sub> H <sub>13</sub>	RC <sub>26</sub> TA
	S(CH <sub>3</sub> )	C <sub>7</sub> H <sub>15</sub>	SC <sub>27</sub> TA
e1	S(CH <sub>3</sub> )	C <sub>8</sub> H <sub>17</sub>	SC <sub>28</sub> TA
f1	S(CH <sub>3</sub> )	C <sub>7</sub> H <sub>15</sub>	RC <sub>27</sub> TA
g1	R(CH <sub>3</sub> )	C <sub>8</sub> H <sub>17</sub>	RC <sub>28</sub> TA



STRUCTURES REPRESENTING TRIAROMATIC STERANES



II



## Stable Carbon Isotope Ratio Mass Spectrometry

Carbon isotope analysis is performed on a dual inlet VG SIRA 10 instrument. The combustion of the samples is performed by a Carlo Erba EA 1108 element analyser directly connected to the inlet system of the mass spectrometer.

The combustion temperature is 1020°C and the carrier gas used was Helium. After the combustion H<sub>2</sub>O and CO<sub>2</sub> are trapped in individual cool traps. The CO<sub>2</sub> gas is then heated up before admission into the mass spectrometer. The whole operation is controlled by an IBM PC50 computer system.

## δ-values

The isotope ratios are given as δ-values in ‰ versus the PDB-standard:

$$\delta^{13}\text{C} = (\text{R sample} - \text{R standard} / \text{R standard}) \times 1000$$
$$\text{R} = {}^{13}\text{C}/{}^{12}\text{C}$$

The PDB-standard (a marine chalk of the Pee Dee-formation, USA) was created by Craig 1957. All results of <sup>13</sup>C/<sup>12</sup>C-analysis of organic matter today are calculated (Craig correction) against this international standard.

## Reproducibility

The precision of the combustion system and the mass spectrometer is controlled by determination of an international calibrated standard, NBS22 oil and a house standard carbon. Replicate analyses are also performed on samples.

## **Abbreviations**

### **List of abbreviations used for lithology description**

(sorted alphabetically)

ang	= angular
bar	= Baryte (mud additive)
bit	= bituminous
bl	= blue/blueish
blk	= black
br	= brittle
brn	= brown/brownish
Ca	= Carbonate (limestone/chalk/dolomite/siderite)
calc	= calcareous
carb	= carbonaceous
cem	= cement used as additive (under "cont") or to describe cemented S/Sst
Chert	= Chert
chk	= Chalk/chalky
cly	= clayey/shaly
cngl	= conglomeratic
Coal	= Coal
Coal-ad	= Coal-like additive (e.g. chromlignosulfonate)
Congl	= Conglomerat
Cont	= Contamination(s)
crs	= coarse grained
dd	= dried drilling mud
dol	= Dolomite/dolomitic
drk	= dark (colour)
dsk	= dusk/dusky (colour)
evap	= Salt/Gypsum/Halite (natural "Other" or as additive "Cont")
f	= fine grained
fe	= ferruginous
fib	= fibres (mud additive/contamination)
fis	= fissile
fos	= fossiliferous
glauc	= glauconite/glauconitic
gn	= green/greenish
gy	= grey/greyish
hd	= hard
ign	= Igneous (material derived from igneous source)
Kaolin	= Kaolin(ite)
kln	= kaolinitic
l	= loose
lam	= laminated/laminae
lt	= light (colour)

m	= medium (colour or grain size)
Marl	= Marl (calcareous claystone/mudstone)
mic	= micaceous
Mica-ad	= Mica used as mud additive
mrl	= marly
No Mat.	= No material left over after washing
ns	= nutshells (mud additive)
ol	= olive
ool	= Oolite/oolitic
or	= orange
Other	= Other lithology/mineral, specified after this word
pi	= pink/pinkish
pl	= pale (colour)
prp	= paint/rust/plastic contaminations/additives
pu	= purple
pyr	= Pyrite/pyritic
red	= red/reddish
rnd	= round/rounded
s	= sandy
sft	= soft
S/Sst	= Sand and/or sandstone
Sh/Clst	= Shale and/or claystone
sid	= Siderite/sideritic
sil	= siliceous/cherty
slt	= silty
Sltst	= siltstone
st	= stained (with natural oil or oil-like additive)
tar-ad	= Tar-like additive (e.g. "Black Magic")
trbfgs	= turbodrilled fragments
Tuff	= Tuff
tuff	= tuffaceous
v col	= various colours
w	= white
wx	= waxy
y	= yellow/yellowish

Table 1 : Lithology description for well NOCS 25/7-3

Depth unit of measure: m

Depth	Type	Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description			
1220.00						0021
	1.42	100	Sh/Clst: brn gy to m gy			0021-1L
1240.00						0022
	1.58	100	Sh/Clst: brn gy to m gy			0022-1L
1280.00						0023
	1.55	100	Sh/Clst: brn gy to ol gy			0023-1L
			tr S/Sst : w, f, l			0023-2L
			tr Cont : w, bar			0023-3L
			tr Other : pyr			0023-4L
1320.00						0024
	0.72	100	Sh/Clst: brn gy to ol gy			0024-1L
			tr S/Sst : w, f, l			0024-2L
			tr Cont : w, bar			0024-3L
			tr Other : pyr			0024-4L
1380.00						0025
	0.58	100	Sh/Clst: brn gy to ol gy, pyr			0025-1L
1410.00						0026
	0.57	100	Sh/Clst: brn gy to ol gy, pyr			0026-1L
1450.00						0027
	0.39	100	Sh/Clst: brn gy to ol gy, pyr			0027-1L
1470.00						0028
	0.50	100	Sh/Clst: brn gy to ol gy, pyr			0028-1L

Table 1 : Lithology description for well NOCS 25/7-3

Depth unit of measure: m

Depth	Type	Grp	Frm	Age	Trb	Sample
Int	Cvd	TOC%	%	Lithology description		
1500.00						0029
	0.39	100		Sh/Clst: brn gy to ol gy, pyr		0029-1L
1550.00						0030
	0.59	100		Sh/Clst: brn gy to ol gy, pyr		0030-1L
1590.00						0031
	0.89	100		Sh/Clst: brn gy to ol gy, pyr		0031-1L
1630.00						0032
	0.85	100		Sh/Clst: brn gy to ol gy, pyr		0032-1L
1670.00						0033
	1.20	100		Sh/Clst: brn gy to ol gy, pyr		0033-1L
1710.00						0034
	1.07	100		Sh/Clst: brn gy to ol gy		0034-1L
1750.00						0035
	0.68	100		Sh/Clst: brn gy to ol gy		0035-1L
1790.00						0036
	0.40	100		Sh/Clst: brn gy to ol gy		0036-1L
1830.00						0037
	0.58	100		Sh/Clst: brn gy to ol gy		0037-1L

Table 1 : Lithology description for well NOCS 25/7-3

Depth unit of measure: m

Depth	Type	Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description			
1870.00						0038
	0.44	100	Sh/Clst: brn gy to ol gy, pyr			0038-1L
1910.00						0039
	0.25	100	Sh/Clst: brn gy to ol gy, pyr			0039-1L
1950.00						0040
	1.09	100	Sh/Clst: m gy to ol gy			0040-1L
1992.00						0041
	0.73	90	Sh/Clst: m gy to ol gy			0041-1L
		10	S/Sst : m gy, f, cem			0041-2L
		tr	Ca : lt y gy			0041-3L
1998.00						0042
	0.73	90	Sh/Clst: m gy to ol gy			0042-1L
		10	S/Sst : m gy, f, cem			0042-2L
		tr	Ca : lt y gy			0042-3L
2004.00						0043
	1.33	100	Sh/Clst: m gy to ol gy			0043-1L
		tr	S/Sst : m gy, f, cem			0043-2L
		tr	Ca : lt y gy			0043-3L
2010.00						0044
	1.44	100	Sh/Clst: m gy			0044-1L
		tr	S/Sst : m gy, f, cem			0044-2L
		tr	Ca : lt gy			0044-3L
2016.00						0045
	1.78	100	Sh/Clst: m gy			0045-1L
		tr	S/Sst : m gy, f, cem			0045-2L
		tr	Ca : lt gy			0045-3L

Table 1 : Lithology description for well NOCS 25/7-3

Depth unit of measure: m

Depth	Type	Grp	Frm	Age	Trb	Sample
Int	Cvd	TOC%	%	Lithology description		
2022.00						0046
	1.47	100	Sh/Clst:	m gy		0046-1L
			tr S/Sst	: m gy, f, cem		0046-2L
			tr Ca	: lt gy		0046-3L
2026.00	swc					0006
	1.45	100	Sh/Clst:	m gy, slt		0006-1L
2028.00						0047
	1.44	100	Sh/Clst:	m gy		0047-1L
			tr S/Sst	: m gy, f, cem		0047-2L
			tr Ca	: lt gy		0047-3L
2034.00						0048
	1.06	100	Sh/Clst:	m gy		0048-1L
			tr S/Sst	: m gy, f, cem		0048-2L
			tr Ca	: lt gy		0048-3L
2037.00	swc					0007
	1.22	100	Sh/Clst:	m gy, slt		0007-1L
2040.00						0049
	1.02	100	Sh/Clst:	m gy		0049-1L
			tr S/Sst	: m gy, f, cem		0049-2L
			tr Ca	: lt gy		0049-3L
2046.00						0050
	1.10	100	Sh/Clst:	m gy		0050-1L
			tr S/Sst	: m gy, f, cem		0050-2L
			tr Ca	: lt gy		0050-3L